

Study of Tight Metal Binding Sites in Plant and Soil-derived HAs

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Beamline(s): X23A2

Humic acids (HAs) are brown environmental materials in plants, peats, sediments and soils. They retain water, selectively sorb solutes, and are essential to healthy and productive soils. HAs have important functions in controlled release of nutrient metals and toxic heavy metals. Studies of the interactions of purified solid HAs with metal cations probe HA microstructures and help to characterize the metal binding sites. Labile cations such as $\text{Ca}_{\text{aq}}^{2+}$, $\text{Co}_{\text{aq}}^{2+}$, $\text{Cu}_{\text{aq}}^{2+}$, $\text{Fe}_{\text{aq}}^{3+}$, $\text{Mg}_{\text{aq}}^{2+}$ and $\text{Mn}_{\text{aq}}^{2+}$ tightly bind to solid HAs in sequential steps.^{1,2}

The objective of this work is to probe the microstructures of HAs by measuring the XAFS spectra of metals (e.g. Co(II) and Co(III)) loaded samples. HAs used in this research were isolated from the free-living marine alga *Pilayella littoralis* (PHA), Water Hyacinth (*Eichhornia crassipes*) leaves and roots (WHL and WHR) and New Hampshire soil (NHA) to confirm previous experimental work and to identify the binding sites.

EXAFS fluorescence spectra were measured on beam line X18B using a closed cycle displacer unit (liquid helium), which allowed us to go down to 58K then allow the sample to warm and take readings in each 50K up to 300K. The HAs samples studied on this beam line were Co(II)-NHA, -PHA, -WHR and -WHL and hexammine Co(III) -NHA to find out if there is any effect of temperature on the metal motion or if there are any phase transitions.

The same experiments have been done in beam lines X23A2 and X10C using refrigerators/cryostats (liquid N_2) at 77K, and we measured more metals and different HAs. The metals were Cd(II), Co(II), Mn(II) and Zn(II). More information and conclusions will be reported after finishing the data analysis.

References

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2. G. Davies, E. A. Ghabbour, N. K. Ghali and M. D. Mulligan, "Tight Metal Binding by Peat and Soil Derived Humic Acids," *Canadian Journal of Soil Science*, in press.